# THE KAISER ALUMINUM DOME

## General Information

# THE KAISER ALUMINUM DOME

Included in this folder is complete information on the erection of the Kaiser Aluminum Dome at Hawaiian Village Hotels in Honolulu, Hawaii. This information will be supplemented with additional data as soon as it becomes available.

All of the information to date is based on our experience with the first Kaiser Aluminum Dome. Bear in mind that it was designed as an auditorium. It might have been a supermarket, a sports arena, or any one of many other applications. Size and design were dictated by ultimate use. Variations of this first Dome are not only practical.... they are immediately possible.

The questions and answers included in this folder have been thoroughly reviewed and approved by our product development department. You may use this information freely and with confidence as to accuracy.

## WHAT DOES THE DOME COST?

Again we are speaking of the first Kaiser Aluminum Dome. This Dome could be duplicated for approximately $4 per square foot of area covered. This is substantially lower than conventional buildings which might be constructed for the same purpose. This figure is for your general information only. Specific cost data will be forthcoming in the near future.

The Hawaiian Village Dome has 16,500 square feet of covered area. It is 145 feet in diameter and is 49½ feet high.

While this Dome was erected in 20 hours (588 man hours, total), we do not wish to emphasize or imply that future Domes could be erected as rapidly. Much depends on the application itself and the conditions - climatic, available labor, etc. - under which the Dome is to be erected.

SATURDAY, JANUARY 12, 1957

At 7:00 a.m. Saturday, January 12, 1957, the first panels arrived and erection began with a crew of 15 men.

By noon 65 panels had been erected.

During the afternoon the labor force was increased to 25 men and 230 panels were erected by the end of the 10 hour shift.

SUNDAY, JANUARY 13, 1957

By 8:45 a.m. the dome had reached 117 feet in diameter.

By lunch time the dome was two-thirds complete.

At the end of the second 10 hour shift the dome was completely assembled and ready for mounting on the foundations.

MONDAY, JANUARY 14, 1957

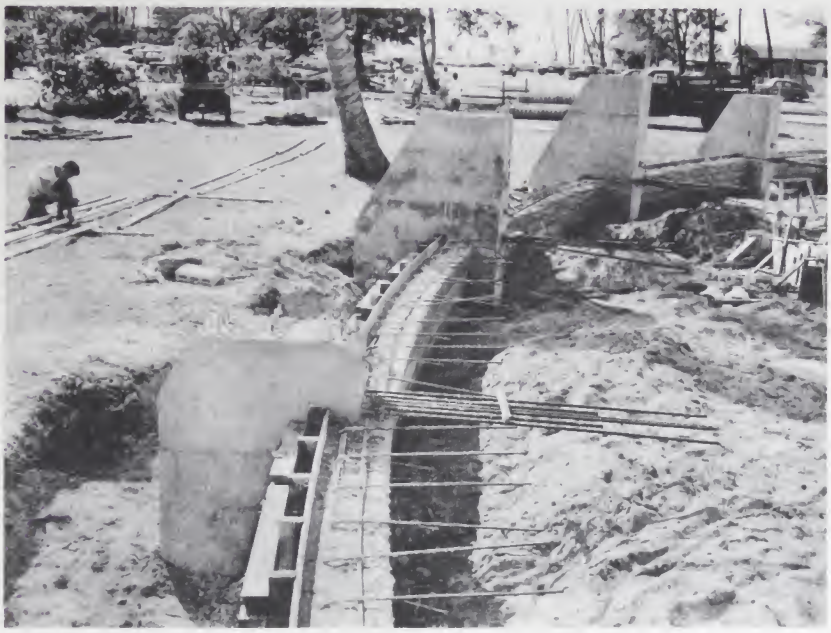
By 10:00 a m. all base supports had been assembled and the dome was being welded in place on its foundation.

After lunch the erection mast was dismantled and removed from the site.

At the end of the third 10 hour shift the cover had been attached to the center pentagon mast opening and the dome was ready for interior treatment and landscaping.

## THE PRELIMINARIES

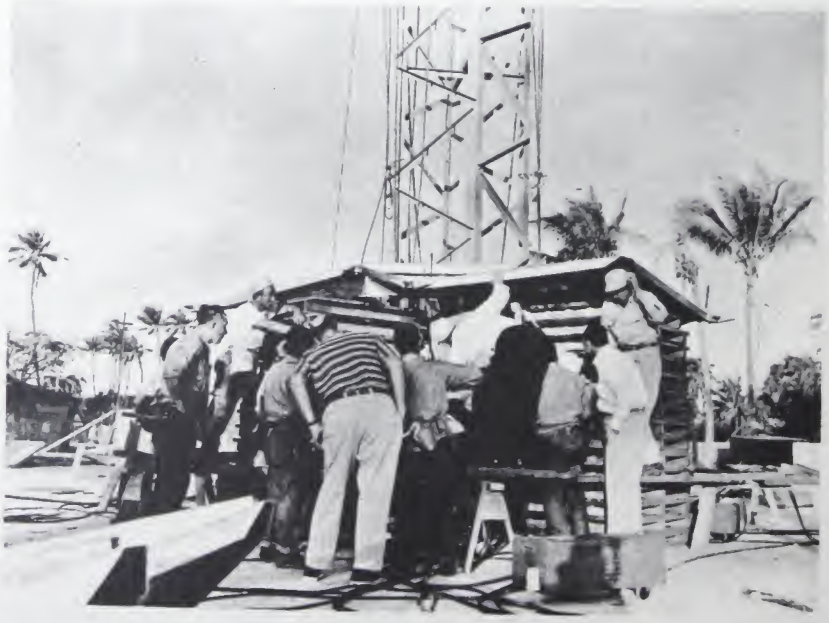

Activity started in Honolulu with the issuance of a Building Permit by the City of Honolulu Department of Buildings. The aluminum dome was thoroughly evaluated by the Honolulu Building Department to insure that it conformed to the Uniform Building Code. The aluminum dome was classed as a Type II, Group B occupancy structure and was admitted under a variance to the Code which established aluminum as a non-combustible structural material.



Concrete foundations and floor slab were poured. The foundations were designed for combined deadweight and soil pullout, necessary to offset lift of the aluminum dome under hurricane conditions. The floor slab was 4" thick concrete reinforced with #10 wire mesh. A 12 foot wide path 8" thick was provided from the outer edge of the slab to the center to allow entry of a 20 ton truck crane.

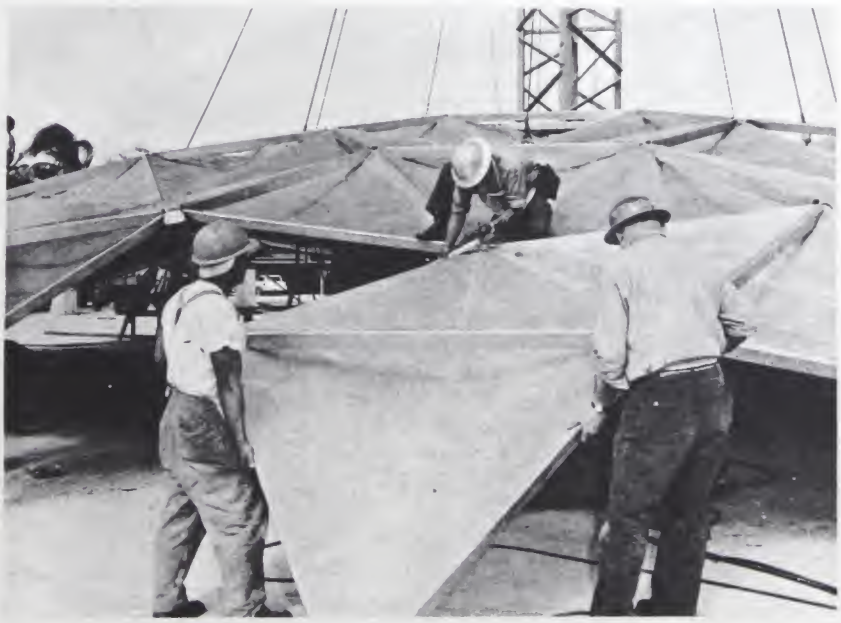
A 96 ft. erection mast was delivered to the job site and placed in position on the floor slab. A 20 ton truck crane with 80 ft. boom was used to erect the mast. The mast was erected with all guy lines and carriage rigging in place. Mast guy lines were attached to five concrete dead men and four hand winches installed to drive the mast carriage.

The 575 structural diamonds arrived in eleven crates which were 26 ft. long, 8 ft. wide, and 9 ft. high.



Shortly after arrival at the Terminal Steel yard the job of subassembling diamond structural elements began. A rectangular shape strut was attached to each of the 575 diamonds with Huck Lockbolts.

In 3½ hours a crew of 15 men subassembled 430 of the diamonds. Preparations were now complete to a point where erection of the dome could begin.

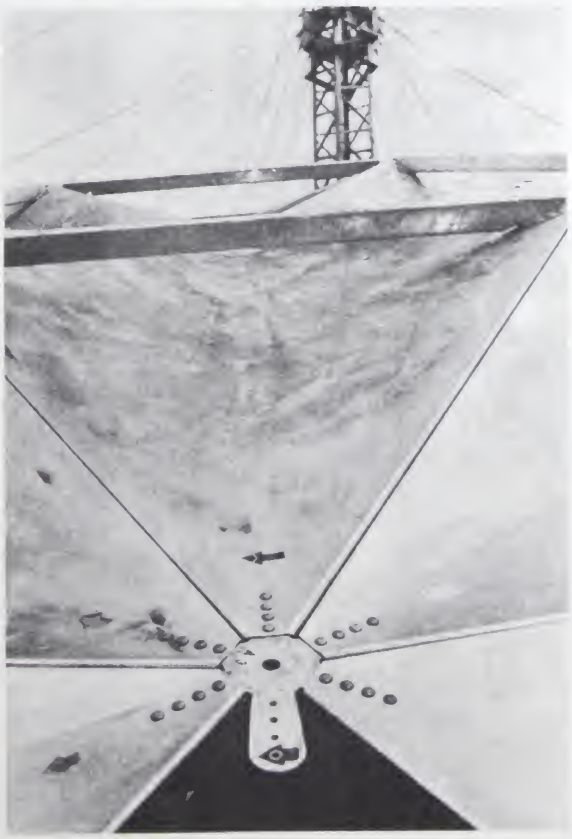


The structural aluminum diamond is being attached to the dome. A total of 575 of these diamonds was required to complete the structure. Ten diamond types were used, varying in length from 8'-11" to 11'-8", and in width from 5'-8" to 6'-10". The diamond panels are made of .081" 61ST6 aluminum alloy fabricated by brake forming. The struts are an integral part of the diamond and are made of .156" 52SH12 aluminum alloy, and also fabricated by brake forming.

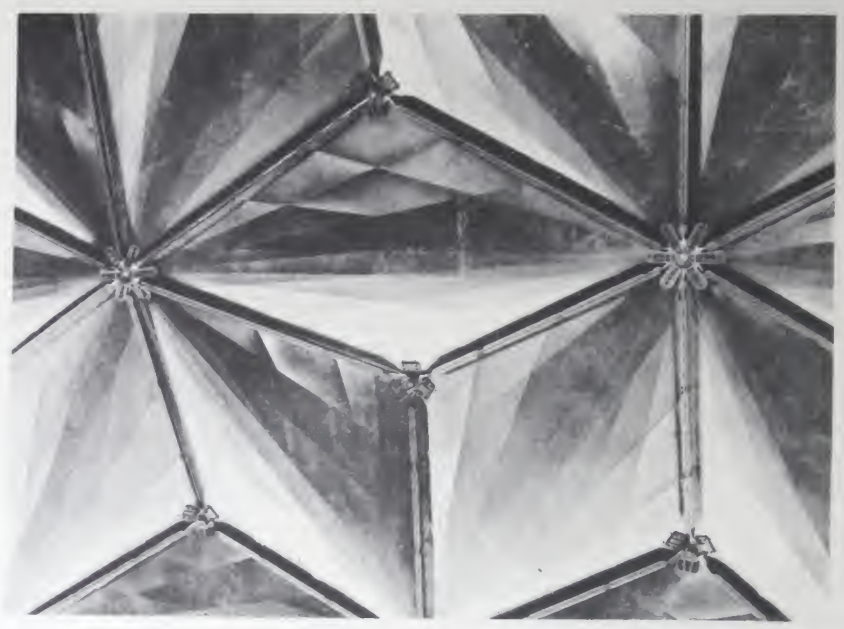
All components of the dome are fastened together with Huck Lockbolts. 1/4" x 3/8" anodized 24ST3 aluminum lockbolts were used throughout. These fasteners have excellent load carrying characteristics and can be driven in approximately one-fifth of the time required to place a conventional nut and bolt with pneumatic tools.

The gusset casting serves two functions. First, it provides a means of attaching an assembly of six diamonds at the extremity of the long diagonal. Second, the gusset casting provides a convenient fitting to which rigging of all types may be attached. It should be noted that flanges of adjacent diamonds are bolted together to provide additional structural support.

The third component is an aluminum hub casting. This casting is made of heat treated 356T6 aluminum alloy. Its purpose is also twofold. First, it provides a means of attaching three diamonds at the extremity of the short diagonal. Second, it provides a structural attachment for the exterior strut. These castings are a universal type and can be used at any spot within the dome regardless of diamond type.



As there are ten types of diamonds in the dome it is necessary to code or identify these diamonds to insure that they are installed in the proper position and in the proper orientation. Both diamond and gusset casting are coded with a colored arrow. The color designates diamond type and the arrow designates diamond orientation.



A view of the underside of the dome shows the location of hub and gusset castings with respect to the long and short diamond diagonal.

The concrete piers used to support the dome are equipped with a steel leveling plate and have provision for 3" of vertical adjustment.

A total of 25 base struts are used to support the dome on its foundations. Vertical tension and compression loads are carried through a 2½" diameter 61S-T6 aluminum pipe strut from the gusset casting to a pivot pin in the steel base shoe. The Kaiser Aluminum Dome expands 3" in diameter under temperature extremes. The tubular support strut is a flexible member that can accommodate this movement. Structural diamonds behind the struts are used to stabilize the dome against rotation. An aluminum pin attached to the lower end of the diamond rides free in the support shoe to accommodate thermal expansion and at the same time restrains the dome against rotation.

The dome is anchored to its foundation by welding the base shoe to the base plate.

The pentagon center opening was bolted together around the erection mast. At this point the weight of the pentagon is supported by five stacks of wooden pallets which are approximately 8 ft. high.

The work crew of 15 men is given instruction on the technique of handling automatic Huck bolt guns. The color coding system and fastening sequence is explained to them. Five of the men are working foremen. Each of these men will later direct a five man assembly crew. The erection sequence is as follows:

1. Attach hub castings. 2. Attach gusset castings. 3. Place diamond on hub and gusset castings. 4. Bolt diamond to hub and gusset castings using two drift pins at each casting. 5. Bolt the diamond flange to adjacent diamond flange.

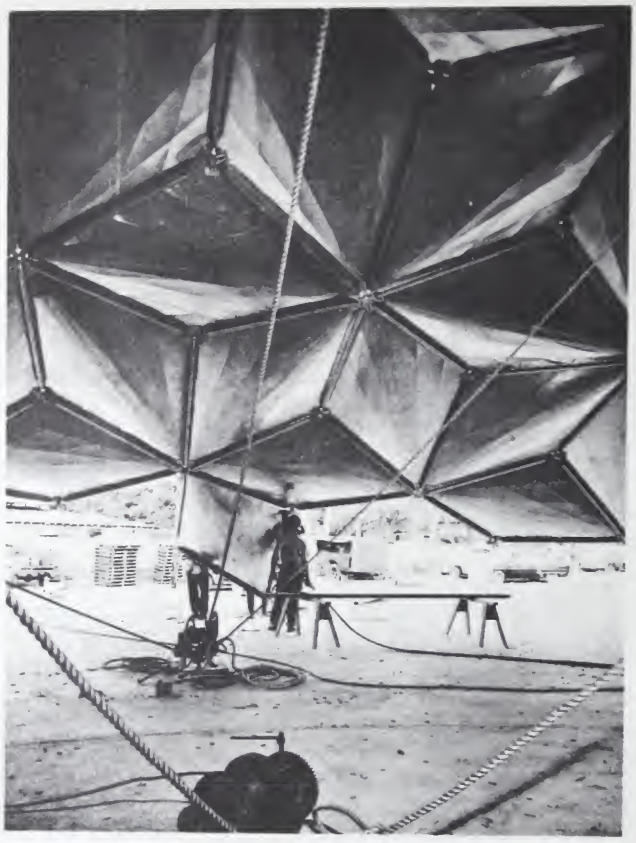


As assembly continues the dome curvature becomes apparent and the structure rapidly approaches ground level. Now ten pennants, which were previously preset under tension to an exact length with 1/8" tolerance, are employed. The upper end of the pennant is attached to the mast carriage and the lower end of the pennant is attached with 1" eye bolts to ten predetermined gusset castings in the dome.

Four 5 ton BB hand winches are used to raise the carriage up the mast with the result that the entire dome structure is raised into the air.

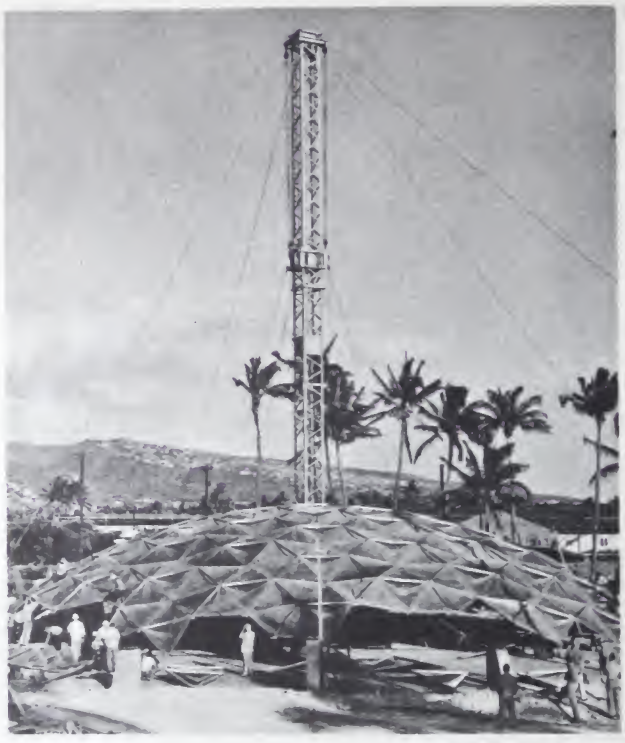
As the dome is raised, assembly inspectors place one diamond in position to determine what ground clearance will be needed for the next row of diamonds to be assembled. The dome is raised only enough at one time to allow addition of one row of diamonds.

As soon as the raise is complete assembly inspectors using color code assembly drawings advise each assembly crew on the type of diamond and gusset casting to be installed, and checks orientation of both components.



While the assembly crews are at work, the rigging crew is lashing the dome to the ground to restrain it against wind loads. During erection of the Kaiser Aluminum Dome wind gusts of 25 mph were encountered frequently and extensive rigging was required to hold the dome in position. 1" manilla lines are attached to gusset castings close to ground level and tied off to eye bolts in the concrete slab.

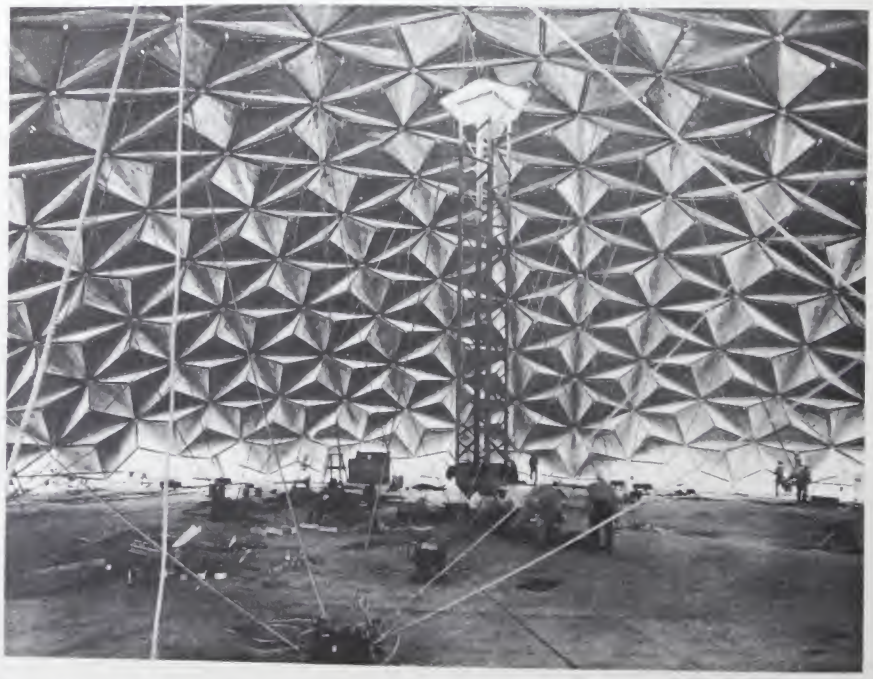
A special forged steel eye nut is used to attach the 1" manilla line to the dome. This nut is so constructed that it may later be released from the outside, allowing the line to drop to the floor. By employing this system no inside scaffolding is required to release these lines when the dome is completed.



The entire process is now repeated. The carriage is drawn up the mast raising the dome to a predetermined height. Assembly crews attach additional diamonds, rigging crews lash the dome against wind loads.

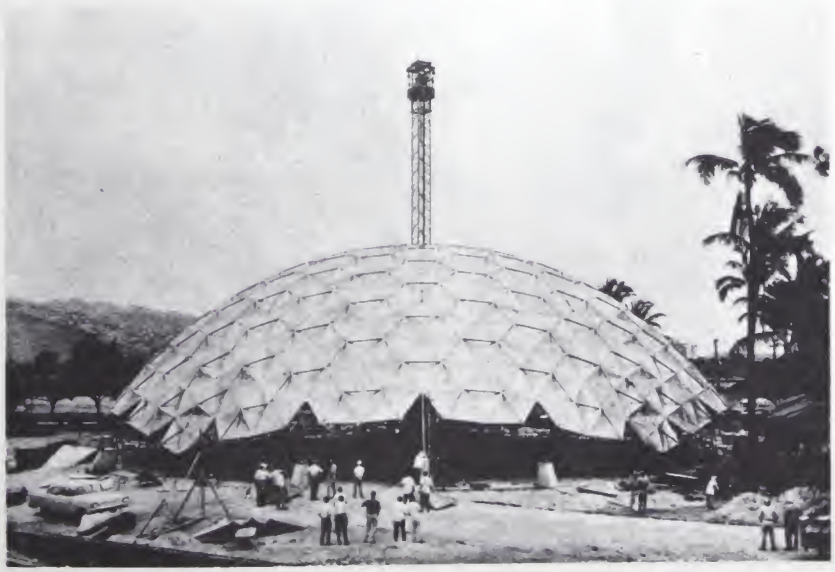
As the dome increases in size the number of tie down lines are also increased. Now, each man in the assembly crew is assigned a tie down line. As the dome is raised, these lines are snubbed and payed off gradually. When the raise is complete the lines are tied out and the assembly crews return to assembly work. The riggers check each tie down line and make such adjustments as are necessary to keep the dome balanced. When the tie down lines are relaxed one man standing at the periphery of the dome can move the entire structure.

As erection progresses, additional diamonds continue to arrive at the job site. These diamonds are delivered according to a predetermined schedule so that only the type of diamonds immediately required for assembly are at the job site. A well organized material handling program was required as storage space at the job site was very limited. Truck access to the job site was limited to one area only, consequently all components were distributed to the assembly station by hand. Ideally, it would be desirable to have truck access to five stations around the dome periphery.



As the dome increases in size wind loads become a more severe problem and additional rigging must be employed. It is necessary to tie down from the outer surface of the dome as well as from the under surface of the dome. At this point ten 5 ton hand winches are mounted on the slab with cables running out to the mast guy line deadmen and back to the outer surface of the dome. By employing this method of rigging the dome is kept under complete control at all times.

The dome now nears completion and the five arches around the dome base begin to take shape. Modified gusset castings are attached to this point.



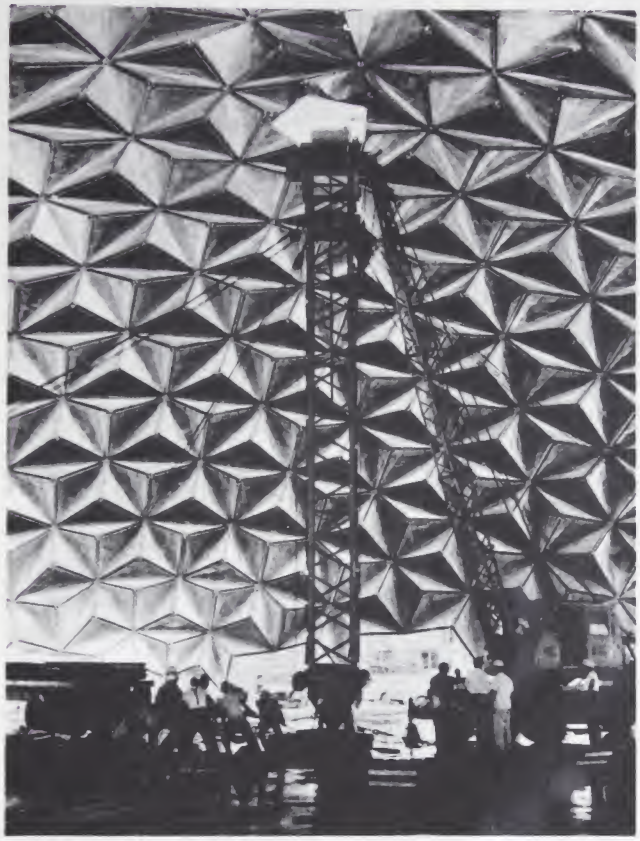
The dome is now assembled and ready for the base support struts to be attached. The entire structure is raised to the maximum elevation allowed by the erection mast.

The base support diamonds are attached to the structure.

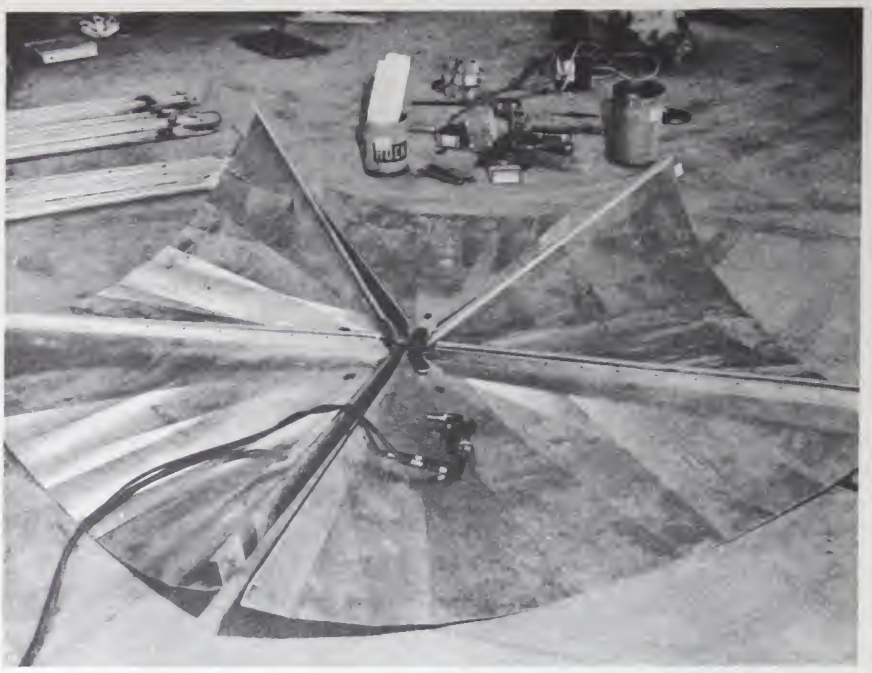
Tie down lines are relaxed. The dome is rotated into position and dropped on its foundations.

Base support shoes are welded to foundation base plates and the dome is now a completed load bearing structure.

All pennant lines are cut loose from the erection mast and the dome settles only 3/4" at the pentagon opening around the mast. The upper half of the erection mast is a bolted construction. It is now taken apart piece by piece by the riggers. A small gin hole is employed to lower each piece to the ground.



The bottom half of the erection mast is lowered to the floor slab with a 10 ton truck crane. The erection mast and all other erection equipment are now removed from the job site.



A cover for the pentagon opening at the center of the dome is assembled and installed.

The structure is made weatherproof by applying Thiokol to all points with a pneumatic hand gun. Other weatherproofing details will be used as dictated by more severe climatic requirements.

Painting the struts provides a finishing touch.

The structure is now complete. Interior treatment and landscaping can proceed.

## ESTIMATED TOTAL DOME COSTS

The following figures show actual man hours needed to fabricate and erect a 150 ft. dome, as well as estimated costs. These figures can be used as a guide in arriving at total dome costs, although each individual fabricator and erector will have varying costs.

Foliowing cost should be added to establish an accurate total:

Freight (from Trentwood to customer)

## MAN HOURS REQUIRED

By Local Fabricator - Erector

### To Complete Fabrication

Diamonds: (626 Made - 575 Reqd.)

| | | |
|---|---|---|
| Brake Form Sunburst | 416 | |
| Shear off Corners | 208 | |
| Brake Form Lips | 312 | |
| Brake Form Flanges | 624 | |
| | | 1,560 |

Base Struts (28 Made - 25 Reqd.)

| | | |
|---|---|---|
| Saw Pipe to Length | 7.9 | |
| Slot Pipe Each End | 15.8 | |
| Saw Plate Fittings | 11.6 | |
| Drill & Machine | 12.8 | |
| (Welding by Sub-Cont.) | | 48 |

| | |
|---|---|
| Foundation Shoes (30 Made - 25 Reqd.) | 48 |
| Assemble Hub Castings | 20 |
| | 1,676 Hours |

Note: No attempt was made to correct total hours to account for fact that extra parts were made. Each fabricator will also have to make a few spare parts.

## ERECTION MAN HOURS (Actual)

Service Time:

| | | |
|---|---|---|
| Prepare yard for matl. | 37 | |
| Unload crates | 130 | |
| Hauling panels to site | 54 | |
| Misc. hauling to site | 51 | |
| Re-crating Huck guns | 19 | |
| | | 291 |

Rigging Time:

| | | |
|---|---|---|
| Erection of mast and rigging | 176 | |
| Dismantle and remove mast | 196-1/2 | |
| Reassemble mast | 33 | |
| | | 405-1/2 |

Erection:

| | | |
|---|---|---|
| Sub-assembly | 131-1/2 | |
| In Hawaii, actual erection was done on Sat. & Sun. 882-1/2 hrs. | 882-1/2 | |
| | | 1,014 |

Sealing:

| | |
|---|---|
| Includes cleaning and caulking | 311-1/2 |
| | 2,022 |

## DOME COSTS

Parts & Services (Fabrication) (Needed for each dome)

| | |
|---|---|
| Alum. (Pipe & Plate) | $ 751 |
| Weld Base Struts | 294 |
| Huck Bolts | 1,250 |
| Adhesive Cartridges | 222 |
| Adhesive | 814 |
| Misc. Bolts & Parts | 1,003 |
| Misc. Services | 251 |
| | $ 4,585 |

Parts & Services (erection) (could be re-used on other domes, or could already be on hand with an erector)

| | |
|---|---|
| Huck Guns (Rented) | $ 1,370 |
| Mast | 4,453 |
| Crane Rental | 712 |
| Equip. Rental | 246 |
| Hauling | 420 |
| Materials | 2,634 |
| Misc. Parts | 1,897 |
| | $ 11,732 |

## DOME COSTS - CONT'D.

Labor Costs

For completion of fabrication

| | | |
|---|---|---|
| 1,676 m-hrs. @ $3.75 | 6,280 | |
| O.H. & P. @ 50% | 3,140 | |
| | | 9,420 |

For Erection (estimated cost)

| | | |
|---|---|---|
| 2,022 m-hrs. @ $4.00 | 8,088 | |
| O.H. & P. @ 50% | 4,044 | |
| | | 12,132 |

Note: Labor costs for fabrication were obtained by multiplying hours by $3.75 (per our original fabricator).
Erection labor costs were estimated charges as labor rates will vary locally.

## TYPICAL COST ESTIMATE (Example)

| | | |
|---|---|---|
| Parts Package (F.O.B. Trentwood) | | |
| (Struts, Castings, Diamonds) Includes Royalty Fee | | $38,720 |
| Fabrication Parts | 4,585 | |
| Fabrication Labor + O.H. & P. | 9,420 | |
| | | 14,005 |
| Erection Parts (can be used again) | 11,732 | |
| Erection Labor + O.H. & P. | 12,132 | |
| | | 23,864 |
| | | $76,589 |

Note: Includes O.H. & P. figures actually encountered on first dome, plus all erection parts, which could be amortized over erection of 3 or more domes.

# KAISER DOME BILL OF MATERIAL

| Part No. | No. Reqd. | Description | Refer to Sheet | Remarks |
|---|---|---|---|---|
| D-1 | 35 | Diamond Panel | 13, 15 | |
| D-1-1 | 5 | " | 13, 15, 16 | Base Diamond |
| D-2 | 135 | " | 14, 15 | |
| D-3 | 60 | " | 13, 15 | |
| D-4 | 105 | " | 14, 15 | |
| D-5 | 40 | " | 13, 15 | |
| D-5-1 | 5 | " | 13, 15, 16 | Base Diamond |
| D-5-2 | 5 | " | 13, 15, 16 | Base Diamond |
| D-6 | 75 | " | 14, 15 | |
| D-7 | 30 | " | 13, 15 | |
| D-8 | 45 | " | 14, 15 | |
| D-9 | 10 | " | 13, 15 | |
| D-9-1 | 5 | " | 13, 15, 16 | Base Diamond |
| D-9-2 | 5 | " | 13, 15, 16 | Base Diamond |
| D-10 | 10 | " | 14, 15 | |
| D-10-1 | 5 | " | 14, 15 | Half Diamond |
| S-1 | 40 | Struts | 12 | |
| S-2 | 135 | " | 12 | |
| S-3 | 60 | " | 12 | |
| S-4 | 105 | " | 12 | |
| S-5 | 50 | " | 12 | |
| S-6 | 75 | " | 12 | |
| S-7 | 30 | " | 12 | |
| S-8 | 45 | " | 12 | |
| S-9 | 20 | " | 12 | |
| S-10 | 15 | " | 12 | |
| H-1 | 400 | Hub Casting | 10 | |
| H-2 | 400 | " " | 10 | |
| H-3 | 350 | " " | 10 | |
| A-1 | 25 | Gusset Casting | 5, 7 | |
| A-1-1 | 5 | " " | 5, 7 | Base Support |
| A-2 | 15 | " " | 5, 7 | |
| A-3 | 40 | " " | 5, 7 | |
| A-3-1 | 5 | " " | 5, 7, 8 | Half Casting |
| A-3-2 | 5 | " " | 5, 7, 8 | " " |
| A-4 | 15 | " " | 5, 7 | |
| A-5 | 20 | " " | 5, 7 | |
| A-5-1 | 10 | " " | 5, 7 | |
| B-6 | 15 | " " | 6, 7 | Base Support |
| A-7 | 10 | " " | 5, 7 | |
| A-7-1 | 5 | " " | 5, 7, 8 | Half Casting |
| A-7-2 | 5 | " " | 5, 7, 8 | " " |
| B-8 | 5 | " " | 6, 7 | |
| B-8-1 | 10 | " | 6, 7 | Base Support |
| A-9 | 5 | " " | 5, 7 | |
| | 5 | Ventilator Panel | 13, 15, 18, 19 | |

| Part No. | No. Reqd. | Description | Refer to Sheet | Remarks |
|---|---|---|---|---|
| A-10 | 5 | Gusset Plate | 9 | |
| A-11 | 1 | Ventilator Gusset | 18 | |
| F-1 | 5 | Foundation Shoe | 21 | |
| F-2 | 5 | " " | 21 | |
| F-3 | 5 | " " | 21 | |
| F-4 | 5 | " " | 21 | |
| F-5 | 5 | " " | 21 | |
| T-1 | 5 | Base Strut | 20 | |
| T-5 | 10 | " " | 20 | |
| T-9 | 10 | " " | 20 | |
| | 5 | Reinforcing Channel | 17 | |
| | 5 | Angle Connectors | 17 | |
| | 55 | Clip Angles | 17 | |
| | 10 | Ventilator Clip | 18 | |
| | 400 | 3/4 x 2-3/4 sq.hd.mach. bolt - cad. plated | 11 | Hub Casting |
| | 400 | 3/4 stl. lockwasher cad. plated | 11 | " " |
| | 400 | 3/4 stl. hex nut, cad plated | 11 | " " |
| | 25 | 1 x 4" hi-strength Hex hd. mach. bolts cad plated | 22 | Base Strut |
| | 25 | 1-1/4" x 4" Hi-strength Hex hd. mach. bolts cad plated | 22 | " " |
| | 25 | 1" Stl. Washer Cad-Pl. | 22 | " " |
| | 25 | 1-1/4" Stl. Lockwasher Cad-Plated | 22 | " " |
| | 25 | 1" Hex Nut Cad. Plt. | 22 | " " |
| | 25 | 1-1/4" Hex Nut Cad. Plt. | 22 | " " |
| | 15 | 3/8 x 3 Stl. Hex Hd. | 19 | Ventilator |
| | | Mach. Bolt - Cad Plt. | 19 | " |
| | 15 | 3/8 Lockwasher-Cad Plt. | 19 | " |
| | 15 | 3/8 Hex Nut - Cad Plt. | 19 | " |
| | 150 | 3/8" x 1" Alum Hex Head Mach. Bolt | 16 | Base Diamonds |
| | 150 | 3/8" Alum Hex Nut | 16 | " " |

## MISCELLANEOUS ALUMINUM REQUIRED FOR S-755 DOME
(Not included in Package)

| | | |
|---|---|---|
| .081 | 6061-T6 | Vent. Baffles (SH. 18)<br>Clip Angles (SH. 17-18)<br>Hold Down Clips (SH. 18)<br>Vent. Opening Angles (SH. 17) |
| .190 | 5052-H34 | Reinforcing Channel (SH. 17)<br>Gusset Plate A-10 (SH. 9)<br>Vent. Gusset A-11 (SH. 18) |
| .500 | 6061-T6 | Paddles (Part 1 - SH. 16)<br>Hub Plate (Part 3 - SH. 16)<br>Base Strut Ends (SH. - 20) |
| .750 | 6061-T6 | Base Strut Ends (SH. - 20) |
| 2-1/2" | Sched. 40 Pipe<br>6061-T6 | Base Struts (SH. - 20) |

| Part No. | No. Reqd. | Description | Refer to Sheet | Remarks |
|---|---|---|---|---|
| | 10,500 | Huck Bolt #CLPBH-C8-3 | | Flange Bolts |
| | 4,000 | Huck Bolt #CLPBH-C12-4 | | Strut to Diamond |
| | 10,500 | Huck Bolt #CLPBH-C12-12 | | Diamond Castings |
| | 10,500 | Huck Collars #LC-F8 | | |
| | 14,500 | Huck Collars #LC-F12 | | |
| | 12 | Qt. Cans 3M EC-1368 Adhesive | | |
| | 20 | Gals "Toluoul" | | |
| | 650 | 6" Diam. Circles .010" Thick, Alloy 1100-0 | | |
| | 44 | 3/4 full gal. cans 3M EC-1712 with EC-1352 Accelerator | | Sealant |
| | 400 | Pyles #250-C12 Plastic Cartridges | | Sealant Application |
| | 400 | Pyles #250-P Plastic Plungers | | Sealant Application |
| | 100 | Pyles #440 Plastic Nozzles, 4" Long, 1/8" Orifice | | Sealant Application |

## EQUIPMENT LIST

| No. Reqd. | Description | Remarks |
|---|---|---|
| 10 | Huck #127 Hydraulic Power Unit | Rented |
| 6 | Huck #125 Gun | " |
| 6 | Huck #126B Gun | " |
| 2 | Huck #42-8 Collar Splitter | Bought |
| 2 | Huck #42-12 " " | Bought |
| 4 | Pyles #250-12 Guns | Bought |
| 1 | Mixer & Cartridge Filler | Borrowed from 3M |
| 50 | 1" Eye Bolts | In gusset castings for tying down dome |
| 50 | 1" Eye Nuts | |
| 20 | 1" Shoulder Eye Bolts | |
| 10 | Modified Vise Grip Pliers | Hold Flanges for Bolting |
| | 3/4" Manilla Rope | Tie Down Dome |
| 5 | Cable Pendants #3 | Sheet 34, 36 |
| 5 | " " #6 | " 34, 36 |
| 5 | " " #7 | " 34, 36 |
| 5 | " " #9 | " 34, 36 |
| | Erection Mast | Sheet 32, 33, 34, 35 |
| 5 | Guy Cables | Sheet 34, 36 |
| 4 | Hand Winches | Bolt on Mast |
| 4 | 5-Part 1/2" Cable | To lift carriage, Sh. 34 |
| 1 | Wooden Crib | Base for Mast |

# KAISER ALUMINUM DOME

The following bill of material covers all parts needed for one S-755 dome (145' diameter):

Page 1 shows all parts obtained in a "Package" from Kaiser Aluminum. The struts and castings will be finished, including color coding. The diamond panels will be sheared to exact size, holes punched, and color coded.

Page 2 shows parts which must be fabricated, as well as miscellaneous fasteners.

Page 3 shows miscellaneous aluminum required for parts on Page 2.

Page 4 shows lockbolts and sealant materials.

Page 5 shows erection equipment, which could be used on a number of domes, for it is not expendable.

# QUESTIONS WE'VE BEEN ASKED ABOUT THE KAISER ALUMINUM DOME

Since the first Dome was built, we've been asked hundreds of questions by architects, engineers, contractors, and others who have some application for the Dome in mind. We've included some of these questions -- with the answers -- in this folder, with the hope that the information will be helpful to you.

1. I'm interested in building a supermarket; and I'd like to put glass in the front of the Dome, if I were to use it. Can you do this?

GLASS MAY BE UTILIZED IN THE DOME TO A VERY HIGH DEGREE. IT WILL BE POSSIBLE TO ENCLOSE THE ENTIRE PERIPHERY OF THE DOME WITH GLASS IF SO DESIRED. HEIGHT OF THE GLASS AND ARCHITECTURAL MOUNTING DETAILS WILL BE DEPENDENT UPON THE ARCHITECT'S REQUIREMENTS.

2. Our school board is considering a new gymnasium for the high school. Is this a practical use for your Dome, and if so how would you heat it?

USE OF THE KAISER ALUMINUM DOME FOR A GYMNASIUM IS AN IDEAL APPLICATION. HEATING OF A DOME IS NO DIFFERENT THAN HEATING ANY OTHER LARGE STRUCTURE. CONVENTIONAL HEATING METHODS SHOULD BE USED.

3. I've noticed that the outside skin of the Dome takes the shape of little depressions. I operate a winter resort in the California Sierras, and I can see where this Dome might make a good cover for our skating rink, but I wondered about the depressions and the possibility of a heavy snow load Is this a problem?

THE ALUMINUM DOME WILL COLLECT SNOW AND ICE; HOWEVER, THIS TYPE OF STRUCTURE HAS INHERENTLY HIGH STRENGTH AND THE ABILITY TO WITHSTAND ANY SNOW LOAD WHICH MAY BE ENCOUNTERED. IT SHOULD BE NOTED THAT EVERY PORTION OF THE OUTER

SURFACE OF THE DOME IS SO ORIENTED AS TO PROVIDE DRAINAGE. IN OTHER WORDS, WATER WILL NOT STAND ON ANY PORTION OF THE SURFACE.

4. I own a manufacturing company, and I'd like to know if you can mount light cranes and storage racks from the Dome ceiling.

IT IS COMPLETELY PRACTICAL TO SUSPEND LIGHT AND INTERMEDIATE LOADS FROM THE UNDER SIDE OF THE DOME STRUCTURE. SUPPORT OF HEAVY CONCENTRATED LOADS FROM THE DOME STRUCTURE IS ALSO POSSIBLE; HOWEVER, THESE CONDITIONS SHOULD BE ANALYSED FOR EACH SPECIFIC REQUIREMENT.

5. We're interested in building a new church, but we were a little worried about the acoustical problems in the Dome. What can be done?

THE HAWAIIAN VILLAGE DOME, WITH NO ACOUSTIC TREATMENT, HAS BEEN SUCCESSFULLY USED FOR CONCERTS AND OTHER FORMS OF ENTERTAINMENT WHERE LARGE AUDIENCES WERE INVOLVED. IF, FOR CERTAIN APPLICATIONS, IT IS FELT THAT SPECIAL ACOUSTIC TREATMENTS ARE REQUIRED, THE GEOMETRIC PATTERN OF THE UNDERSIDE OF THE DOME SURFACE PRESENTS AN ALMOST INFINITE NUMBER OF POSSIBILITIES FOR TREATMENTS, WHICH CAN BE MADE AT MODERATE COST.

6. We might want to consider the aluminum Dome for grain storage. How leak-proof are these Domes?

THE DOMES CAN BE COMPLETELY WATERPROOFED VERY ECONOMICALLY SINCE THE AREA WHICH REQUIRES WATER-PROOFING IS FAR LESS THAN THAT OF CONVENTIONAL STRUCTURES. A NUMBER OF COMPLETELY SATISFACTORY WATERPROOFING TECHNIQUES ARE AVAILABLE DEPENDING UPON THE CLIMATIC REQUIREMENT. AND IT SHOULD BE POINTED OUT THAT THE DESIGN OF THE DOME IS SUCH THAT WATER AUTOMATICALLY DRAINS AWAY FROM ALL JOINTS.

7. We may want to utilize the Dome for a civic auditorium, but we'd also like to work some color variation into the exterior finish. Is this possible?

ARCHITECTURAL COLOR VARIATIONS MAY BE ACHIEVED BY PAINTING; HOWEVER, IT IS UNNECESSARY TO PAINT THE DOME FOR CORROSION PROTECTION BECAUSE OF THE ALUMINUM'S NATURAL RESISTANCE TO THE ELEMENTS. DUE TO ALUMINUM'S REFLECTIVE QUALITY ANOTHER INTERESTING POSSIBILITY FOR NIGHT COLOR TREATMENT IS A SERIES OF COLORED LIGHTS DIRECTED AT THE DOME.

8. Pictures of the Dome I've seen don't show any supports or overhead beams in the building. How do we know that the thing will stand up?

THE DOME SHAPE IS INHERENTLY ONE OF THE STRONGEST STRUCTURAL FORMS KNOWN. STATIC LOAD TESTS HAVE BEEN CONDUCTED ON LARGE SCALE PORTIONS OF THE

DOME WHICH ESTABLISHED THAT THE STRUCTURE WILL RESIST LOADS UP TO 100 POUNDS PER SQUARE FOOT. THE UNIFORM BUILDING CODE REQUIRES THAT DOMES BE DESIGNED TO WITHSTAND ONLY 16 POUNDS PER SQUARE FOOT. THE MOST SEVERE CODE REQUIREMENT FOR ROOF LOADING OF CONVENTIONAL BUILDINGS IS ON THE ORDER OF 45 POUNDS PER SQUARE FOOT.

9. We're interested in building an auditorium here in Southern California but the building code is very rigid on earthquake-proof structures. We've noticed that the Dome you erected in Hawaii just rests on concrete piers. Would this kind of construction satisfy the codes?

THE UNIQUE METHOD OF SUPPORTING THE KAISER ALUMINUM DOME IS ADEQUATE TO SATISFY EARTHQUAKE REQUIREMENTS ACTUALLY, A STRUCTURE OF THIS TYPE IS PROBABLY SAFER UNDER EARTHQUAKE CONDITIONS THAN THE CONVENTIONAL MASONRY BUILDING.

10. I'm head of the exploration department for an oil company. We're doing offshore drilling, and I wonder if one of your Domes could be used to cover our drilling rigs out in the ocean?

THIS IS PROBABLY AN IDEAL APPLICATION. THE LIGHTWEIGHT DOME CAN BE ADDED TO AN OFFSHORE DRILL ISLAND WITH LITTLE OR NO REVISION TO THE ISLAND STRUCTURE. IF REQUIRED, THE DOME COULD BE TAKEN DOWN AND MOVED TO ANOTHER LOCATION. ALSO, ALUMINUM HAS EXCELLENT CORROSION RESISTANCE UNDER EXPOSURE OF THIS TYPE

11. Being an architect, I've been very interested in the development of this dome, but it looks to me like you're offering a "building kit". I can't see how the architect will fit into the picture.

THE KAISER ALUMINUM DOME IS - IN A SENSE - A PREFABRICATED STRUCTURE. HOWEVER, THE BASIC STRUCTURAL PRINCIPLE IS FLEXIBLE TO A POINT WHERE THE ARCHITECT HAS A GREAT DEAL OF FREEDOM OF DESIGN. THE ARCHITECTURAL APPEARANCE OF THE STRUCTURE WILL BE DEPENDENT TO A VERY HIGH DEGREE ON THE ARCHITECT'S TREATMENT OF THE GROUND LEVEL CLOSURES.

12. Seems to me that I'd heard about another aluminum dome structure built by a company in the East. What's the difference between yours and theirs, if any?

THE DOME PROBABLY REFERRED TO IS MADE UP OF A STRUCTURAL ALUMINUM FRAMEWORK COVERED WITH FIBREGLASS PANELS. IN OTHER WORDS, SEPARATE COMPONENTS ARE USED TO PROVIDE STRUCTURE AND COVER.. THE KAISER ALUMINUM DOMES COMBINE BOTH THE STRUCTURE AND COVER IN ONE STRUCTURAL ELEMENT IN THE STRESSED SKIN BUILDING PANEL, AND AT FAR LESS COST PER SQUARE FOOT COVERED.

13. Is the Kaiser Aluminum Dome design based on the geodesic principle?

THE KAISER ALUMINUM DOME IS TRIANGULATED IN

ACCORDANCE WITH THE GEODESIC PRINCIPLE ORIGINALLY ESTABLISHED BY R. BUCKMINSTER FULLER. THE KAISER ALUMINUM DOME IS UNIQUE IN THAT IT IS THE FIRST STRESSED SKIN ALUMINUM DOME OF THIS TYPE AND IS A PERMANENT STRUCTURE.

14. Can the general appearance of the outer side of the Dome be changed?

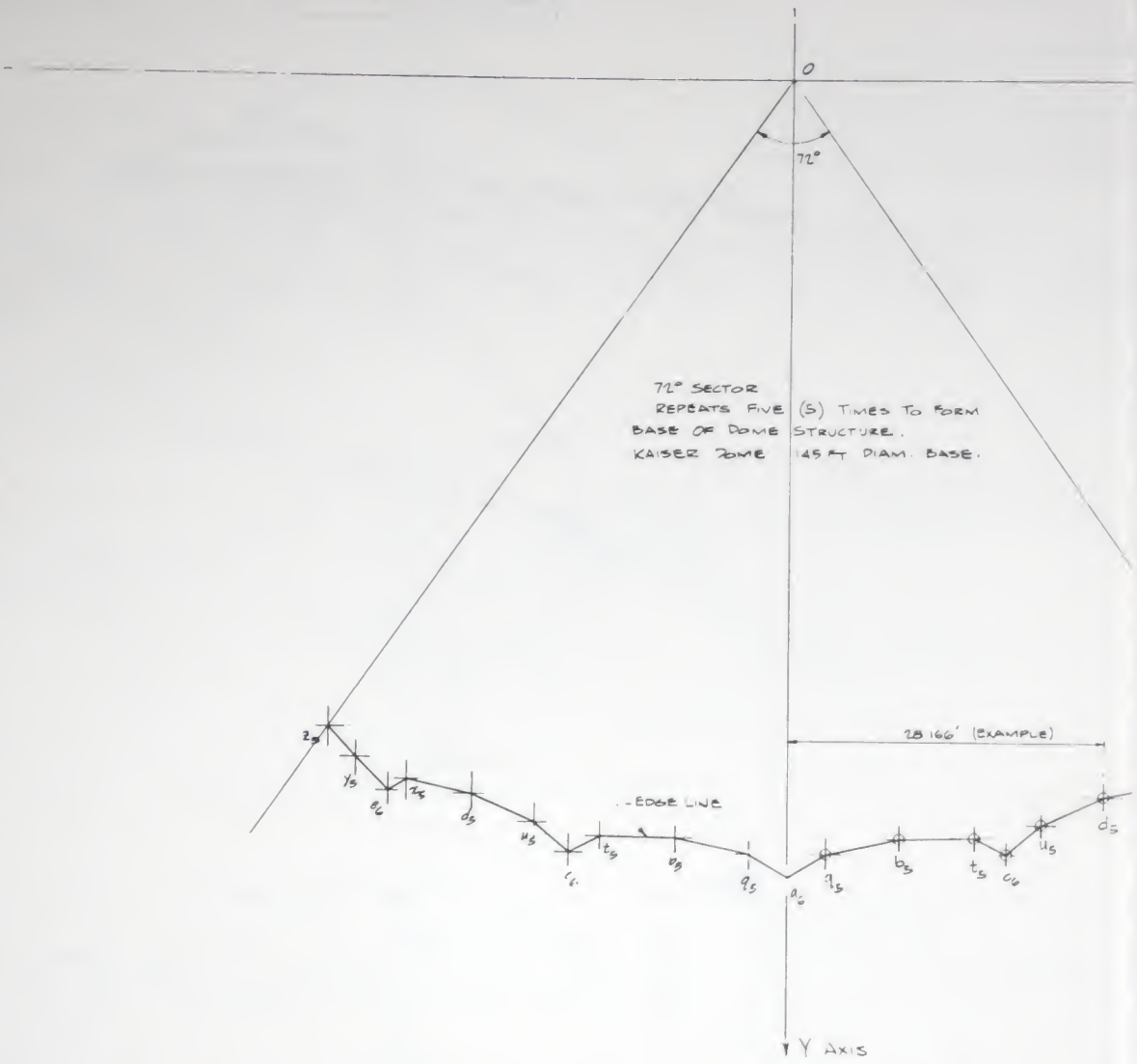
THE EXTERNAL APPEARANCE OF THE KAISER ALUMINUM DOME IS DEPENDENT UPON STRUCTURAL REQUIREMENTS. IT CANNOT BE VARIED WITHOUT ADDITIONAL COST. A COMPARATIVELY SMOOTH SURFACE CAN BE ACHIEVED BY ADDING AN EXTERNAL SKIN TO THE OUTER SURFACE OF THE DOME.

15. I own a professional football team and one of our big problems -- as far as spectators are concerned -- is playing in rain or snow. Is there any possibility that this Dome idea might work out as a covering for football stadiums and baseball parks?

IT IS CONTEMPLATED THAT FUTURE APPLICATIONS OF THE ALUMINUM DOMES WILL INVOLVE MUCH LARGER SIZES THAN THOSE CURRENTLY AVAILABLE. RESEARCH AND DEVELOPMENT OF EXTERMELY LARGE DIAMETER STRUCTURES IS NOW UNDERWAY.

16. If I needed a Dome immediately could one be built?

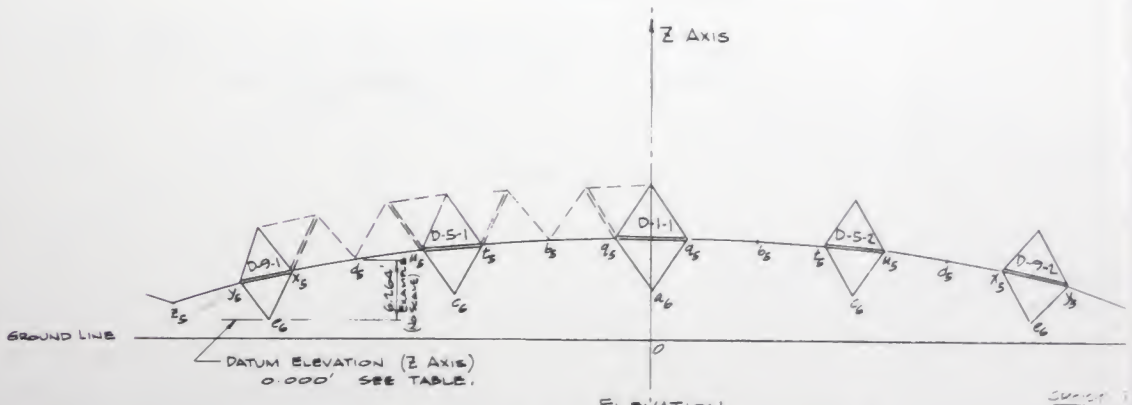
YES. WITHIN PRACTICAL LIMITS OF SIZE, KAISER ALUMINUM DOMES SIMILAR TO THE ONE AT THE HAWAIIAN VILLAGE CAN BE ENGINEERED AND ERECTED IMMEDIATELY FOR A WIDE VARIETY OF APPLICATIONS.




PLAN VIEW

SECTOR OF DOME BASE

8'=1-0




ELEVATION

KEY TO COORDINATE POINTS OF BASE

NOT TO SCALE

SUPPORT
SEE
COORDINATE
DRAWING
SHEET 2
(1) EQ
(2) "
(3) "
(4) "
(5) "

| GEOMETRY & DETAILS FOR FOUNDATION | S-755 SHT 4 |
|---|---|
| REFERENCE DRAWINGS | NO |

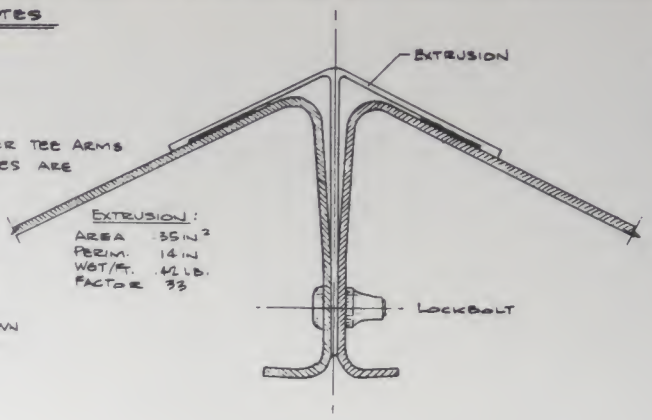
## PROPOSAL AND APPLICATION NOTES

### PROPOSAL #1

- EXTRUDED COVER STRIP
- BEAD OF SEALANT MATERIAL UNDER TEE ARMS
- EXTRUSION STRIP APPLIED AS FLANGES ARE FASTENED WITH LOCKBOLTS
- EXTRUSION MUST BE FORCED DOWN BETWEEN FLANGES TO PROVIDE COMPRESSION ON SEALANT

a. ⊖ SLOT IN STRIP / ⊖ HOLE IN FLANGE } NOT ALIGNED

b. ⊖ HOLE & SLOT LINED UP NOW,
   A. BEFORE EXTRUSION FORCED DOWN
   b. AFTER " " "
   READY TO INSERT LOCKBOLT




EXTRUSION:
AREA .35 IN²
PERIM. 14 IN
WGT/FT. .42 LB.
FACTOR 33

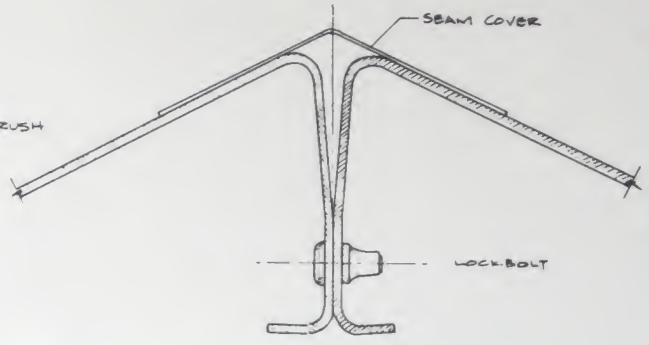
### ARGUMENTS

PRO
- SEALANT MATERIAL PROTECTED FRO WEATH MECHANICAL DAMAGE
- SURFACE CLEANING NOT CRITICAL
- TAPE OR SEALANT BEAD CAN BE DP OR APPLICATION
- DOES NOT REQUIRE SKILLED LABOR FOR A
- NO REPLACEMENT REQUIRED

CON
- COMPLICATES ERECTION SEQUENCE
- REQUIRES RATHER EXPENSIVE EXTRUSION
- MULTIPLE LENGTHS AND SHOP PUNCH O OF
- MAY REQUIRE COMPLICATED COVER ATE

### PROPOSAL #2

- SHEET SEAM COVER
- 3003-0 .010" x 3"
- CONTACT ADHESIVE SPRAY OR BRUSH APPLIED TO SURFACES
- ROLL WITH FORMED ROLLER FOR ADHESION

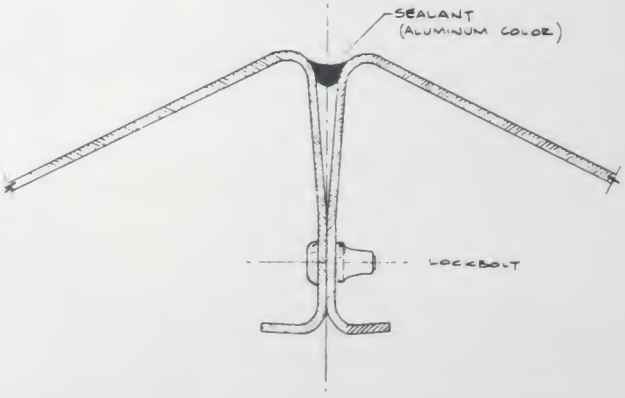



PRO
- SIMPLE APPLICATION AND RAPID
- DOES NOT REQUIRE SKILLED LABOR
- RELATIVELY SIMPLE TO PATCH OR PLACE

CON
- SEAL DEPENDS ON ADHESIVE BOND
- MECHANICAL DAMAGE DESTROYS WEA ER SEA

### PROPOSAL #3

- "THIOKOL" SEALANT EC 312 (3M)
- APPLIED WITH CAULKING GUN
- USE "FROZEN-THIOKOL" SEALANT
- STROKE SEALANT FOR POSITIVE BOND
- SEALANT MATERIAL FACTORY MIXED AND SHIPPED FROZEN IN 6OZ. OR 12 OZ. CARTRIDGES READY FOR USE AFTER 0 MIN. THAW AT 70°F



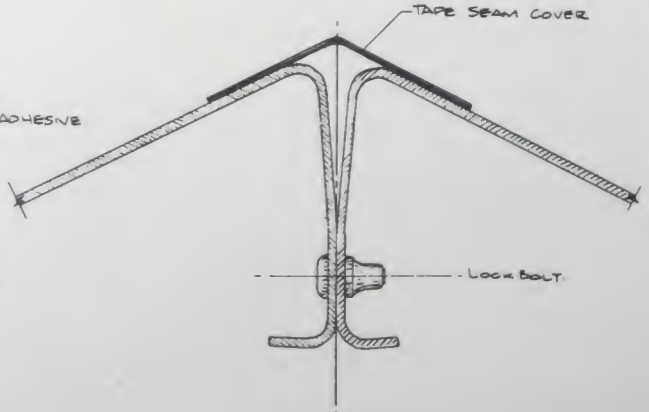

PRO
- SEALANT MATERIAL IN PROTECTED FROM MECHANICAL DAMAGE
- PROVEN PRODUCT (3M) IN BUILDING
- ELIMINATE LABOR OF MIXING SEALANT
- BETTER QUALITY CONTROL ON THIOKOL

CON
- SEAL DEPENDS ON APPLICATION SURFACE CLEANING OF PANEL FLANGES
- DETERIORATION OF MASTIC DURING STORAGE
- REQUIRES STORAGE OF CARTRIDGES
- METHOD REQUIRES SEMI-SKILLED

### PROPOSAL #4

- SHEET SEAM COVER, TAPE FORM
- BACKING OF PRESSURE-SENSITIVE ADHESIVE
- 3003-0 .010" x 3"
- 3M #425 TAPE* (OR EQUAL)
- ROLL WITH FORMED ROLLER FOR POSITIVE BOND.

*AVAILABLE .00525" x 3" (TO DATE)




PRO
- RAPID AND EASY APPLICATION
- REPAIR CONSISTS OF RETAPING
- ADHESIVE PROTECTED FROM WEATHER BY
- DOES NOT REQUIRE SKILLED LABOR FOR

CON
- SEAL DEPENDS ON ADHESIVE BOND
- MECHANICAL DAMAGE OR TAPE POSSIBL BY VA
- TAPE NOT COMMERCIALLY AVAILABL

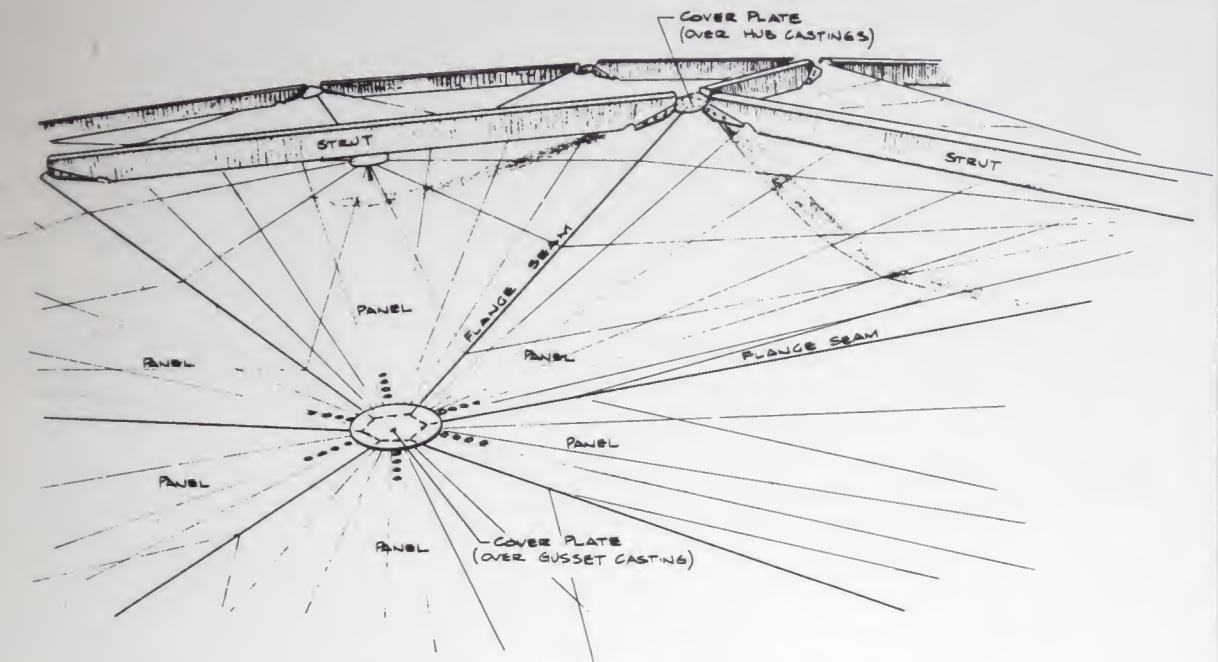
## SECTIONS

TYPICAL SECTION THRU FLANGES OF ADJACENT DIAMOND PANELS.
SHOWS VARIOUS ALTERNATE SEALING PROPOSALS FOR FLANGE JOINT.

FULL SIZE

| REFERENCE DRAWINGS | NO. |
|---|---|

| BILL OF MATERIAL | | | | | |
|---|---|---|---|---|---|
| MARK | No. Req'd | WT. | SIZE | MATERIAL | REMARKS |




SKETCH

SHOWING RELATIONSHIP OF AREAS TO BE SEALED

NO SCALE

NOTE:
COVER PLATE DETAIL SAME FOR ALL CASTING COVER PLATES, I.E.

6" DIAM. 3003-O .010" DISK.
BRUSH OR SPRAY COAT CONTACT SURFACES WITH EC 1360 (OR EQUAL)
FORM 6" Ø DISK TO SHAPE OF PANEL SURFACES WITH HAND OR ROLLER.
BEAD OF "THIOKOL" AROUND RIM OF DISK TO SEAL EDGE.

CLEANING REQUIREMENTS

ALL ALUMINUM SURFACES TO BE COATED WITH ADHESIVE MATERIAL MUST BE FREE OF DUST AND GREASE. WIPE CLEAN WITH SOLVENT (TOLUOL, OR EQUAL) CLEANING MUST PRECEDE ALL SEALING PROCEDURE.

KAISER ALUMINUM & CHEMICAL SALES, INC.
OAKLAND 12, CALIFORNIA
PRODUCT DEVELOPMENT

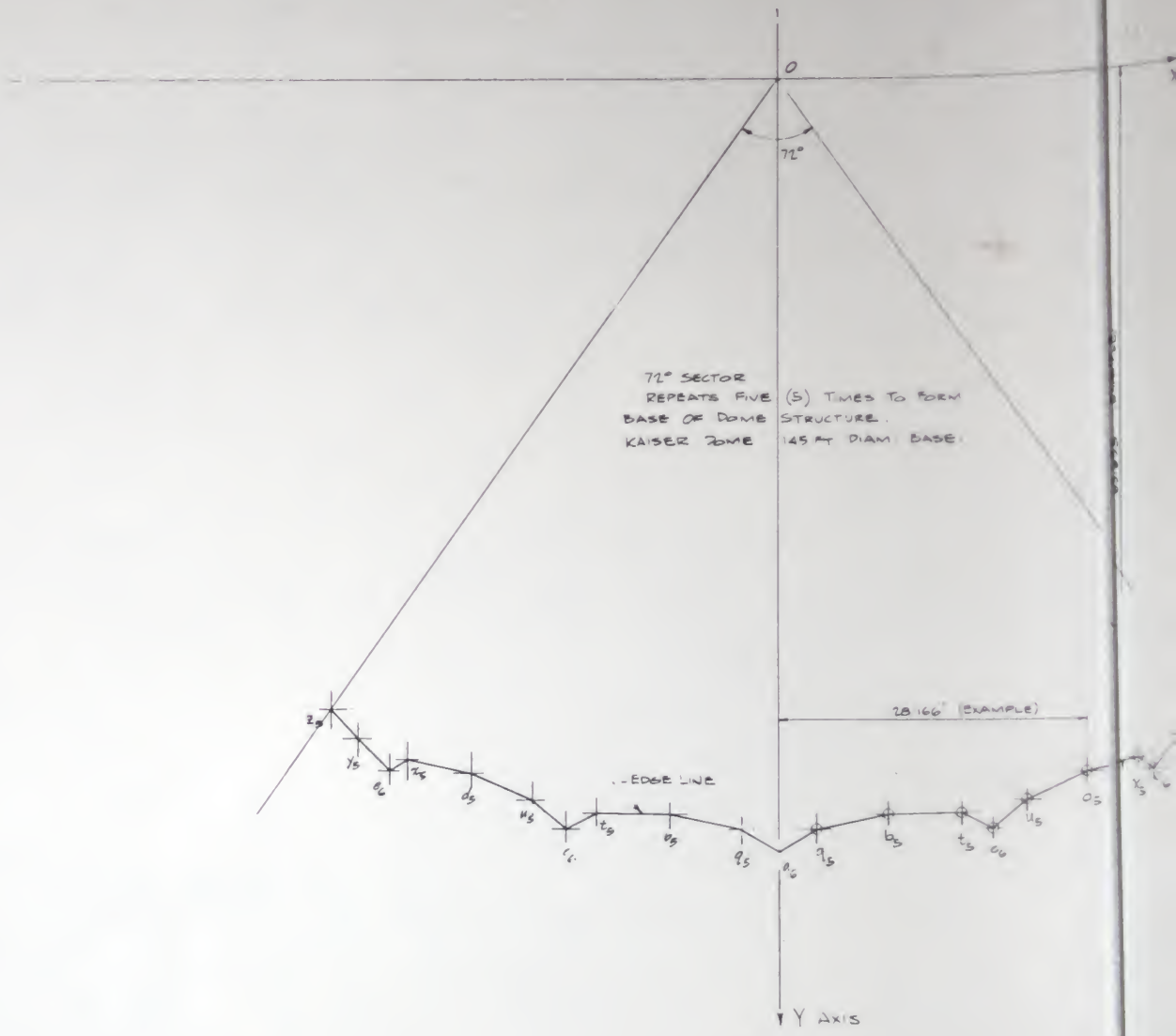
FOR
LOCATION

WEATHER SEALING PROPOSALS
STANDARD DOME DETAIL.

SCALE: NONE
DATE: FEB. 11, 1957
DRAWN BY: K.R. JOHNSON
DRAWING NO. S-811



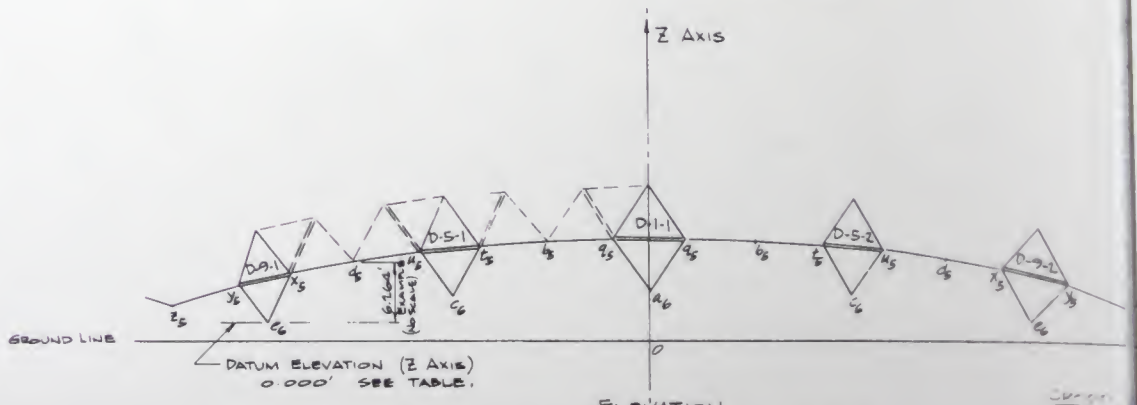
| NO. | DATE | REVISION | BY | APP. |
|---|---|---|---|---|




PLAN

SECTOR OF DOME BASE

$\frac{1}{8}$"=1'-0




ELEVATION

KEY TO COORDINATE POINTS OF BASE
NOT TO SCALE

| GEOMETRY & DETAILS FOR FOUNDATION | S-755 SHT 4 |
|---|---|
| REFERENCE DRAWINGS | NO |

SHEET 4

(1)
(2)
(3)
(4)
(5)

| BILL OF MATERIAL | | | | | |
|---|---|---|---|---|---|
| MARK | No. Req'd | WT. | SIZE | MATERIAL | REMARKS |

X Axis

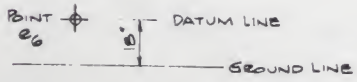
COORDINATES: BASE ELEMENTS

| POINT | X FEET | Y FEET | Z FEET |
|---|---|---|---|
| $q_5$ | 3.406 | 68.842 | 9.445 |
| $t_5$ | 16.751 | 67.413 | 8.562 |
| $u_5$ | 22.637 | 66.157 | 7.786 |
| $x_5$ | 34.096 | 62.501 | 5.526 |
| $y_5$ | 38.606 | 60.573 | 4.335 |
| $b_5$ | 10.023 | 67.516 | 8.707 |
| $d_5$ | 28.166 | 63.695 | 6.264 |
| $z_5$ | 42.058 | 57.889 | 2.676 |
| $a_6$ | 0.000 | 70.937 | 3.884 |
| $c_6$ | 19.541 | 68.789 | 2.763 |
| $e_6$ | 35.687 | 63.488 | 0.000 |

NOTE:
SEE EXAMPLE OF LAYOUT FOR POINT $d_5$ ON PLAN VIEW.

NOTE:
DATUM ELEVATION 0.000'
BASE OF DIAMOND D-9 AT POINT $e_6$.

NOTE: SEE REFERENCE DRAWING (S-755, SHEET 4)
ELEVATION OF DATUM POINT $e_6$ (0.000') (FOR KAISER ALUMINUM HAWAIIAN DOME, 145 FT DIAM.) ABOVE GROUND LINE EQUALS 1'-6" (18")




ELEVATION OF DATUM LINE ABOVE GROUND MAY BE VARIED TO SUIT DESIRED BASE CONDITIONS.

X AXIS

REFERENCE KEY.
DRAWING S-755 SHEET 4.
POINT
OF.
SHEET 23
$e_6$
$c_6$
$a_6$

| NO. | DATE | REVISION | BY | APP |
|---|---|---|---|---|

KAISER ALUMINUM & CHEMICAL SALES, INC.
OAKLAND 12, CALIFORNIA
PRODUCT DEVELOPMENT

FOR
LOCATION

BASE COORDINATES & LAYOUT 145 FT. DIAM. KAISER DOME

SCALE: AS SHOWN
DATE: APRIL 15, '57
DRAWN BY: K. E. JOHNSON
DRAWING NO.: S-755 SHEET 23

| BILL OF MATERIAL | | | | | |
|---|---|---|---|---|---|
| MARK | No. Req'd | WT. | SIZE | MATERIAL | REMARKS |



COORDINATES: BASE ELEMENTS

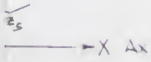
| POINT | X FEET | Y FEET | Z FEET |
|---|---|---|---|
| $q_S$ | 3.406 | 60.842 | 9.445 |
| $t_S$ | 16.751 | 67.413 | 8.562 |
| $u_S$ | 22.637 | 66.157 | 7.786 |
| $x_S$ | 34.096 | 62.501 | 5.526 |
| $y_S$ | 38.606 | 60.573 | 4.335 |
| $b_S$ | 10.073 | 67.516 | 8.707 |
| $d_S$ | 28.166 | 63.695 | 6.264 |
| $z_S$ | 42.058 | 57.889 | 2.676 |
| $a_6$ | 0.000 | 70.937 | 3.884 |
| $c_6$ | 19.541 | 68.789 | 2.763 |
| $e_6$ | 35.687 | 63.488 | 0.000 |

NOTE:
SEE EXAMPLE OF LAYOUT FOR POINT $d_S$ ON PLAN VIEW.

NOTE:
DATUM ELEVATION 0.000'
BASE OF DIAMOND D-9 AT POINT $e_6$.

NOTE: SEE REFERENCE DRAWING (S-755, SHEET 4)
ELEVATION OF DATUM POINT $e_6$ (0.000') (FOR KAISER ALUMINUM HAWAIIAN DOME, 145 FT DIAM.) ABOVE GROUND LINE EQUALS 1'-6" (18")


ELEVATION OF DATUM LINE ABOVE GROUND MAY BE VARIED TO SUIT DESIRED BASE CONDITIONS.




REFERENCE KEY
DRAWING S-755 SHEET 4
POINT
SHEET 23
AIS $e_6$
$c_6$
$a_6$
$u_6$
$r_6$

| NO. | DATE | REVISION | BY | APP. |
|---|---|---|---|---|

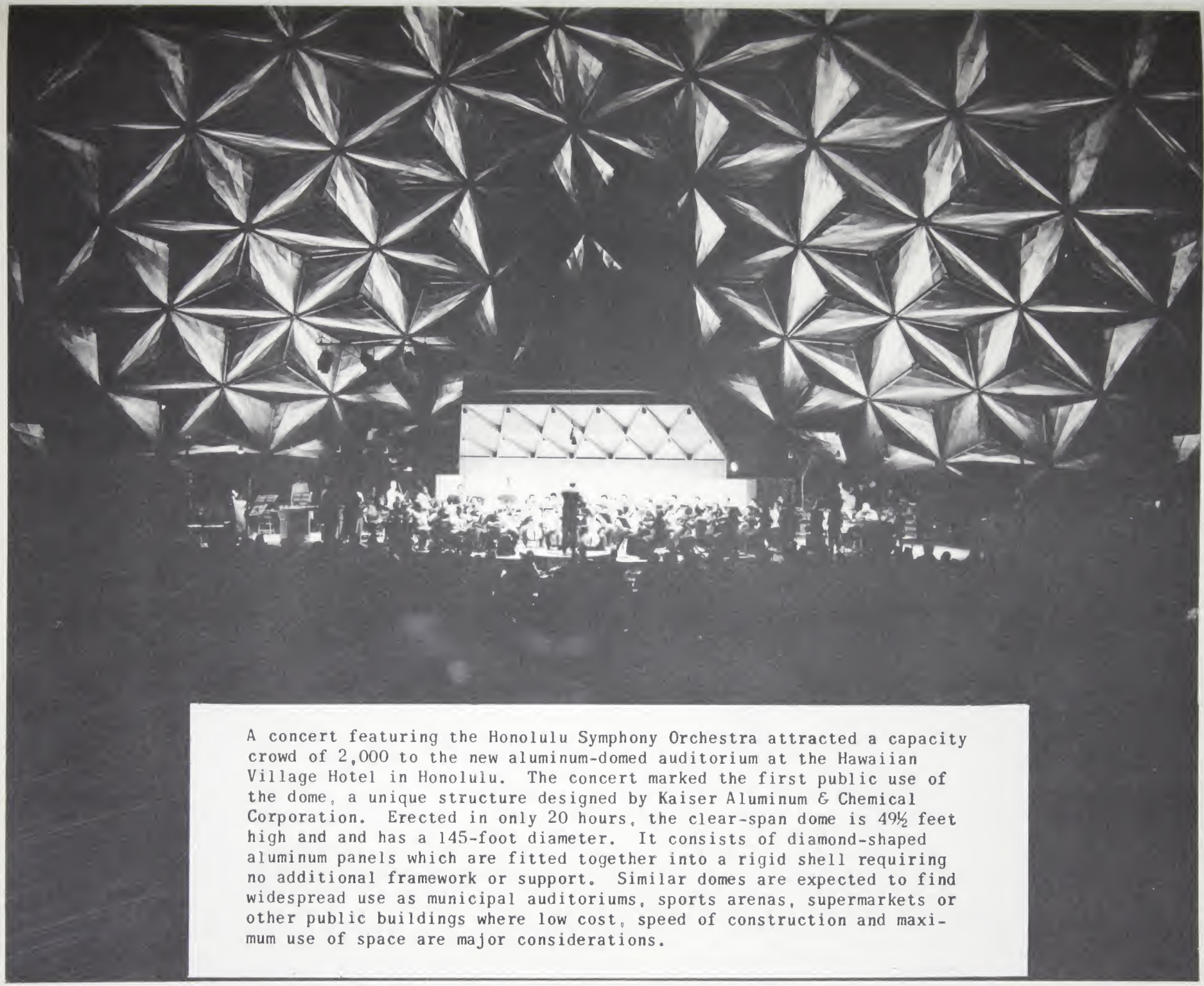
**KAISER ALUMINUM & CHEMICAL SALES, INC.**
OAKLAND 12, CALIFORNIA
PRODUCT DEVELOPMENT

FOR
LOCATION

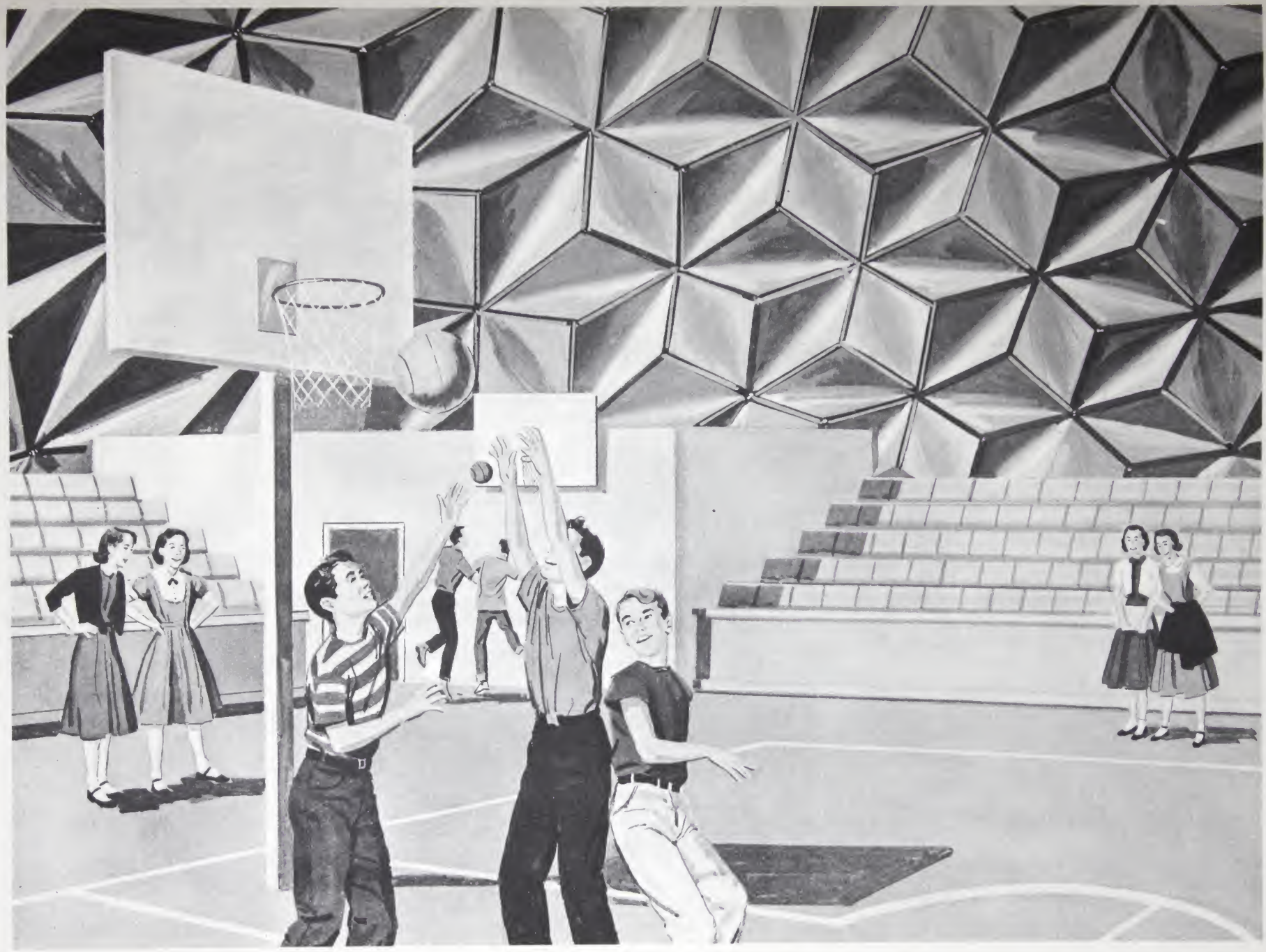
BASE COORDINATES & LAYOUT
145 FT. DIAM. KAISER DOME

SCALE: AS SHOWN
DATE: APRIL 25, '57
DRAWN BY: K. E. JOHNSON
DRAWING NO.: S-755
SHEET 23

A new tourist attraction at the Hawaiian Village Hotel in Honolulu is this aluminum-domed auditorium, first structure of its kind ever built. Designed by Kaiser Aluminum & Chemical Corporation, the dome is 49½ feet high, 145 feet in diameter and has a seating capacity of nearly 2,000. Its rigid aluminum shell, made of diamond-shaped panels which are geometrically arranged and bolted together, requires no interior support. Other major advantages include its low cost, speed of erection (20 hours) and high strength. Architects foresee many uses for stressed-skin aluminum domes, including municipal auditoriums, sports arenas, supermarkets, theaters, museums and other types of public buildings.

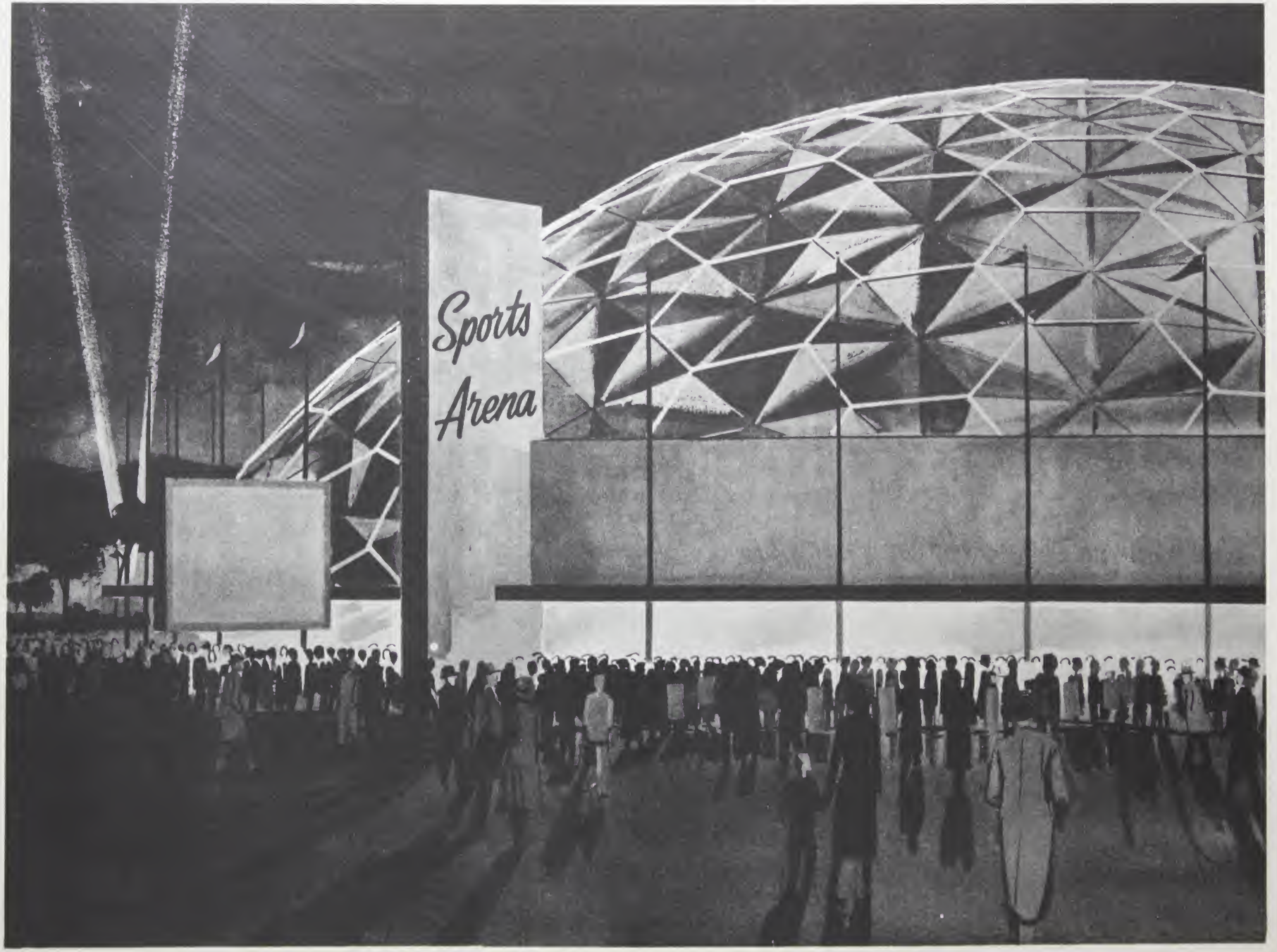


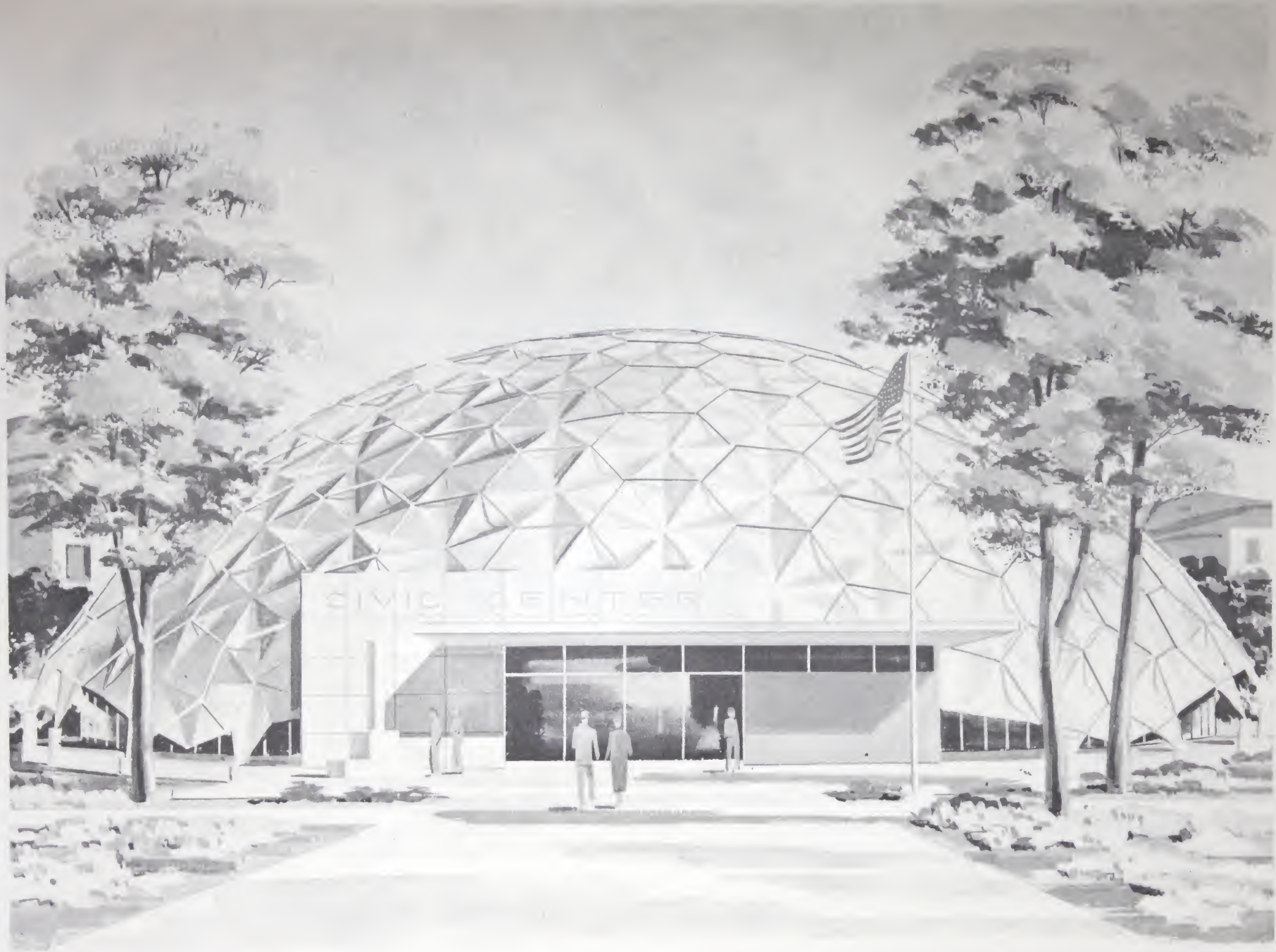
A concert featuring the Honolulu Symphony Orchestra attracted a capacity crowd of 2,000 to the new aluminum-domed auditorium at the Hawaiian Village Hotel in Honolulu. The concert marked the first public use of the dome, a unique structure designed by Kaiser Aluminum & Chemical Corporation. Erected in only 20 hours, the clear-span dome is 49½ feet high and and has a 145-foot diameter. It consists of diamond-shaped aluminum panels which are fitted together into a rigid shell requiring no additional framework or support. Similar domes are expected to find widespread use as municipal auditoriums, sports arenas, supermarkets or other public buildings where low cost, speed of construction and maximum use of space are major considerations.



APPLICATION OF THE KAISER ALUMINUM DOME - SCHOOL GYMNASIUM

APPLICATION OF THE KAISER ALUMINUM DOME - SPORTS ARENA



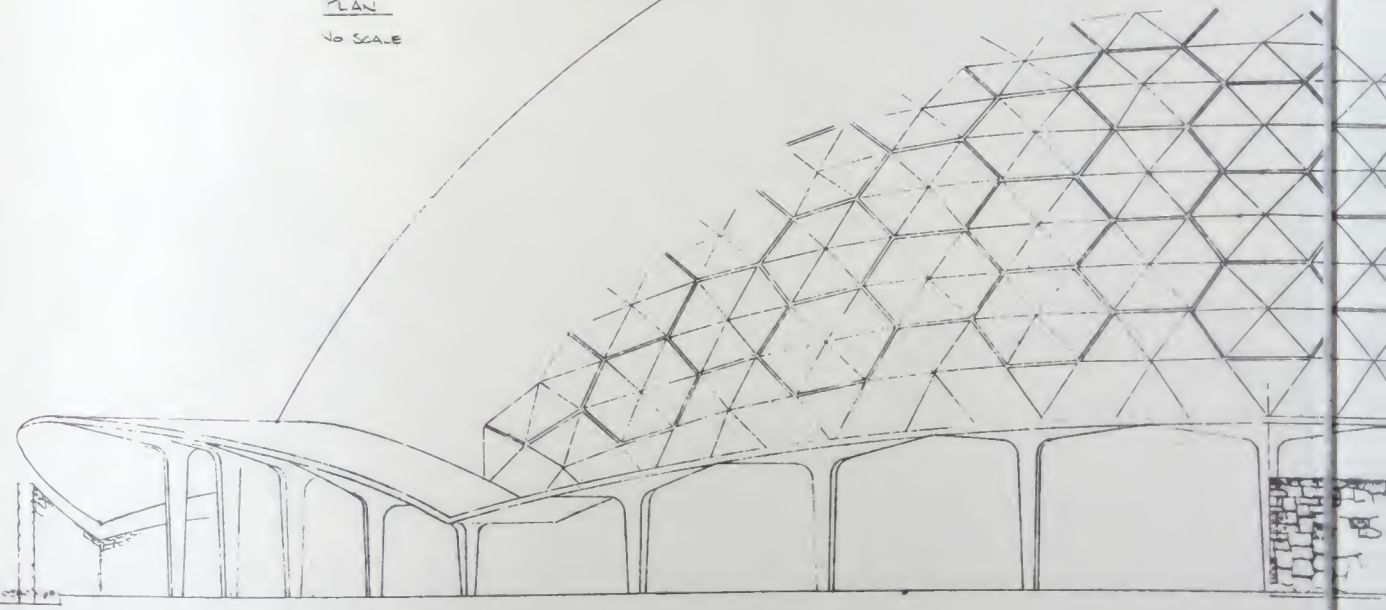



APPLICATION OF THE KAISER ALUMINUM DOME - CIVIC CENTER

APPLICATION OF THE KAISER ALUMINUM DOME - SUPER MARKET


PLAN

NO SCALE



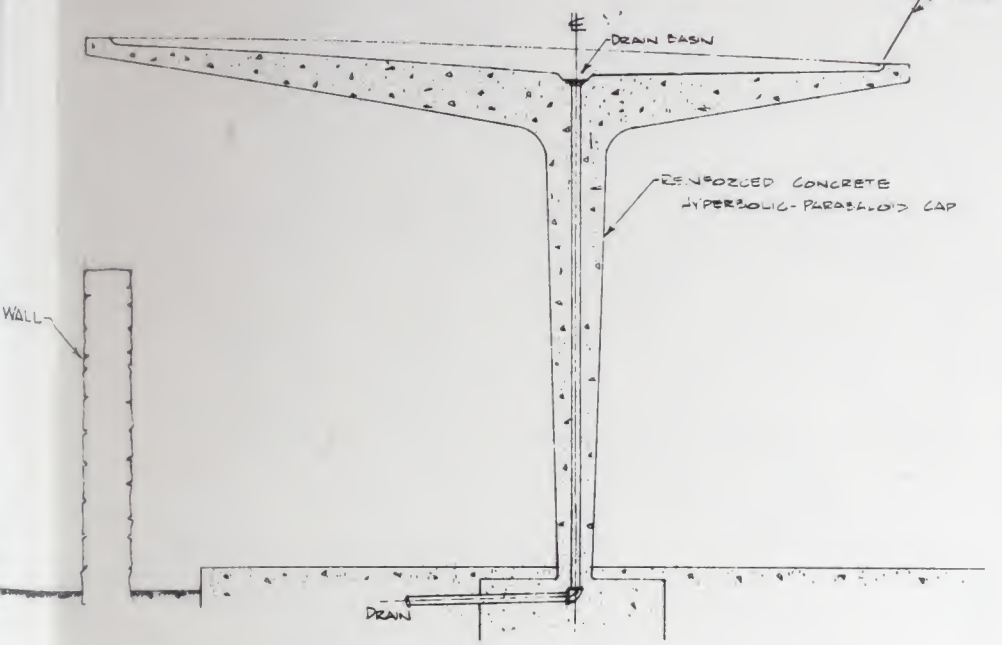
LAVA WALL NOT SHOWN

ELEVATION

$\frac{1}{8}$"=1'-0

| REFERENCE DRAWINGS | NO. |
|---|---|

| BILL OF MATERIAL | | | | | |
|---|---|---|---|---|---|
| MARK | No. Req'd | WT. | SIZE | MATERIAL | REMARKS |




SECTION AT TYPICAL COLUMN
3/8"=1'-0

LAVA ROCK WALL

KAISER ALUMINUM & CHEMICAL SALES, INC.
OAKLAND 12, CALIFORNIA
PRODUCT DEVELOPMENT

FOR
LOCATION HAWAII

PRELIMINARY LAYOUT DETAILS
150' DOME - HONOLULU, HAWAII

SCALE 3/8"=1'-0
DATE MAR 8, 1957
DRAWN BY K R JOHNSON
DRAWING NO. S-819



| NO. | DATE | REVISION | BY | APP |
|---|---|---|---|---|

DO-1 MAY 1957 – 3M